# Future Recording Requirements and Capabilities in the Oil and Gas Pipeline Industry

## Turning Science Fiction into Practical Applications

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## INTRODUCTION

In the early morning hours of a summer day in the southeastern United States, the President of a transmission pipeline company receives an emergency call informing him that there has been a substantial rupture in one of the company's pipelines. Precise details are not known, however, emergency personnel and company response teams have already been dispatched, and the appropriate agencies are being contacted. As one might expect, the first priorities in a situation like this are to stabilize the location and to isolate the subject pipeline to eliminate the possibility of secondary damage related to the incident. However, what happens after the initial response, repair, and cleanup may not always be as clear-cut as one might hope.

Questions such as – What caused the problem? Could it have been avoided? Did the company's operations personnel respond rapidly, and according to a predetermined protocol? – are but a few examples of what must be determined before conclusions can be reached. It seems that there are always more questions than there are answers in these kinds of situations. The task of investigation and analysis can be tedious, time consuming, and may not provide definitive closure to many of these questions. But does it have to be this way? Future developments may provide ways for these questions to be answered quickly, and allow for implementation of proactive techniques and procedures that will promote rapid response and greater probability of avoidance.

## BACKGROUND

Since the onset of large-scale deployment of computerized automation systems in the 1970's, we have been inundated with a never-ending stream of technology advancements, and projections for what's in store for the future. While technology has indeed continued to advance at an exponential rate, it seems that the expectations of managers and the general public have always tended to outpace practical limitations. This is apparent in many aspects of everyday life, and is largely fueled through Hollywood productions, science fiction publications and other media, with visions of fantastic monitoring and control systems that can do anything with a few simple keystrokes, or even conversational voice commands. Suppliers of industrial control and monitoring systems continue to struggle with the dilemma of wanting to satisfy the broad expectations of their customers, and producing systems that perform the required tasks safely, reliably and economically. While most would agree that safety and reliability must be the first priority of any real-time control system, the third and fourth generation systems commonly found in today's marketplace are very capable of satisfying this requirement. Recent advances in available technologies are now making it possible for suppliers to consider new tools that will help optimize ongoing operations and predict the onset of problems before they cause substantial disruption to the operation. Furthermore, increased regulatory pressure is leading to development of new applications that utilize past system performance in training simulations, and allow for precise analysis of historical information for incident review and operating compliance evaluations. While these types of applications are still in their infancy, they promise to bring significant benefit to operating companies and regulatory agencies as they mature.

Today most pipeline companies maintain at least a minimal amount of historical information pertaining to their daily operations. In any given installation one might find this information residing in many different forms, and frequently on disparate servers. In the simplest instance, one might find that a pipeline company uses the SCADA system's historical data archive (or another third party product) for real-time data, and a commercial relational database (or even flat files) for alarm and event information. This information may also be subject to some form of tape or optical media for long-term storage. While SCADA vendors have generally done a reasonable job at providing mechanisms for saving this kind of information from their domains, they have typically not provided good tools for the retrieval and post incident analysis of such information.

The task of assembling an accurate picture of what happened before, during and after a pipeline incident is similar to putting together a complex jig saw puzzle, but never being able to get it quite completed. One reason for this is that these unrelated sources of information, and the associated retrieval processes, are generally not synchronized with respect to time, and may not be capable of providing all of the necessary information. Piecing together related elements from each source, in the correct sequential order, and with respect to time, can be very tedious and prone to errors, even in the simplest cases. When additional information such as real-time model history, command and telemetry history, and others are also considered, this manual approach becomes completely impossible to deal with.

Pipeline operators, software vendors and regulators have been aware of this problem, and have been exchanging views and trying new approaches for some time now. In recent years we have seen the advent of "historical playback" tools incorporated with pipeline SCADA systems that provide a fairly clean linkage between current real-time and historical information, in a near operational context. But these are only relative to the SCADA system, and only in a limited form at that. We have also seen that modeling and simulation suppliers are beginning to consider the operational context of the real-time control system with their products. This is especially true with real-time and predictive modeling systems, training simulators, and to some degree, scheduling and optimization tools.

Some of the larger operating companies have undertaken projects attempting to integrate the SCADA and modeling environments into a "seamless" architecture from an operational point of view, but are still failing to adequately deal with the treatment and use of historical data. While there have been some attempts to produce the "perfectly integrated" system, these projects have generally failed, or at least have never achieved the final objective. This is largely due to technology limitations, lack of cooperation between suppliers of related products, and of course, budget constraints. However, it is apparent from the work already done in the field that there are many possibilities within our grasp. Near-term advances in computing hardware and software technologies will pave the way for many of the inherent complexities of these kinds of systems to be overcome, without breaking the bank.

## SYSTEM ARCHITECTURE AND CAPABILITIES

Future systems will include all of the basic control and operational capabilities of current systems, but they will go much further when it comes to providing quality analysis and historical review capabilities. SCADA systems are expected to include a seamless tie-in to an extensive archive of historical information, which will not only include past telemetry information, but also events, operator actions, and calculated parameters from real-time models or other sources. The tools required to perform such an analysis will include the ability to dynamically switch from a pure historical playback to a "what-if" scenario simulation, based on the current system state at the time a deviation from history is requested. This capability is referred to *Full Scope Inline Simulation*.

While full scope simulators for training systems have been present for many years in some industries, this technology has not been widely embraced by the pipeline industry. Although this situation is slowly changing, pipeline operators have been reluctant to implement such systems due to many factors, which include cost, duplication of resources, and complexity. The advent of new technologies that promise to effectively integrate full scope simulation capabilities into the real-time operational environment will serve to better justify the use of such tools.

As illustrated in Figure 1, such systems will be viewed as a single integrated environment, combining online real-time operational components with a substantial historical information archive system, along with simulation and predictive modeling applications. These systems will share a common configuration database, and will provide seamless integration of real-time SCADA, historical playback, and simulation through a single common graphical user interface.

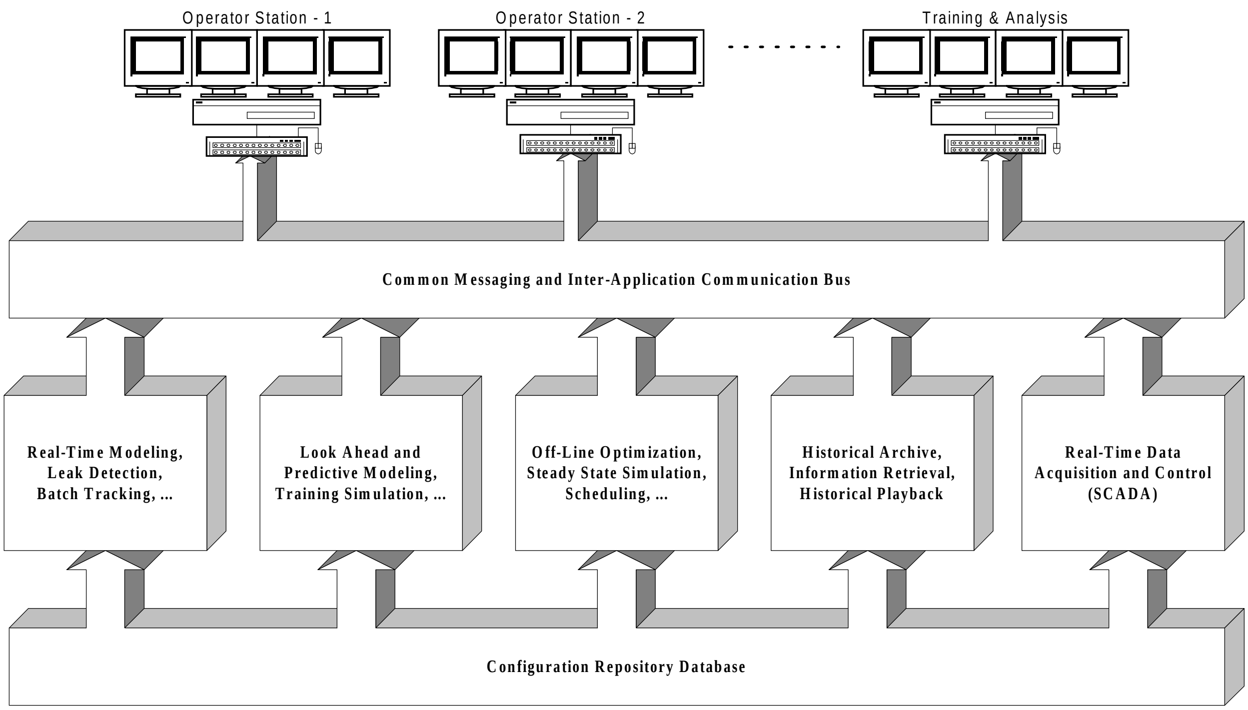


*Figure 1: Conceptual architecture for a Full Scope Inline Simulation system.*

The tools required to implement a Full Scope Inline Simulation system are not trivial, and will most likely not be completely developed by any single source. Besides the obvious improvements required in the underlying SCADA environment, these systems will require significant research and development efforts in areas which include standards for specification of physical configuration details, high performance real-time data archival, historical data retrieval, historical playback, real-time simulation and predictive modeling, to name just a few. Each of these functions will provide an integral part of a complete system.

At the foundation of such a system there must be a common configuration repository containing the precise details of the physical environment. This information will be used by the SCADA system to define the acquisition and treatment of information from field measurement devices, as well as device control functions. It will be used by the historical archive and retrieval functions to deal with the data elements associated with the system, and it will provide critical physical details to the simulation and modeling functions. This "database" can be considered as the glue that holds all of the system functionality together, and make it possible for each of the related functions to have a consistent view of the environment upon which they are operating.

The historical playback capability is the heart of this type of system. It will provide on-demand playback of archived information from a specified time base, in either real-time, accelerated time, or slowed time. The functionality of this application will include the ability to observe past operations in the exact context of the actual time of data capture, including all operator actions and related system functions. In addition to this, it will be possible for a user to interact with the system to observe other operational characteristics which might have occurred during any given playback period. If, during a playback review session, a user (or investigator) wishes to invoke a "what-if" scenario, a context switch from pure playback mode to a predictive simulation will be immediately and seamlessly initiated. Results of these actions might optionally be saved to a location outside of the normal historical archive for later review and analysis.

It is obvious this kind of capability will require that extensive historical information be maintained for immediate online access. This will require intelligent data collection and archive techniques that can handle massive amounts of information at very high data rates. Storage technologies must also be capable of providing high volume read and write access to archived information, and must have substantial capacity in order to keep multiple years of information online. To fully realize the capabilities of the playback and simulation functions, every piece of information acquired, calculated, observed, entered, or simulated must be saved at real-time resolution. This will include not only physical measurements and sensor information, but also detailed telemetry information, alarms and events, real-time model results, and calculated parameters which will present a simulated "mirror" of real world conditions to aid incident investigations or routine analysis of anomalous operations.

User interfaces employed in systems today provide many of the display and interaction capabilities necessary to support a Full Scope Inline Simulation system. However, many improvements will be required to allow for the seamless integration of the various components that make up such systems. User interfaces will need to provide simultaneous display and interaction with virtually every component of the system. Use of standard inter-application communication technologies will be essential to the successful integration of not only the user interface, but also to all of the applications with which it must operate. To fully realize the potential of the play back and analysis functions, all user interface transactions and commands (i.e., data entry and parameter changes, command requests and associated sequences, display navigation, etc.) must be archived along with all other data and related information.

## BENEFITS

The benefits of Full Scope Inline Simulation systems are extensive. Not only will these kinds of systems provide accurate and precise details to support incident analysis, they promise to aid pipeline operations and management personnel with the development of proactive and preventive strategies. This will most likely be accomplished through ongoing training and formal reviews of past operations, and will be leveraged from the historical playback and simulation attributes of the system.

It is anticipated that new regulations will eventually require all operators to have some number of hours of simulation training each month as a condition of their continuing certification. New operators will most likely be subjected to rigorous training programs, and these integrated playback and simulation systems should allow for this type of training to be easily executed in a reasonable period of time.

The business enterprise will realize the benefits of having an extensive resource of historical information available for planning, efficiency analysis, optimization studies, and cost analysis, to name just a few. Access to the historical archive resource will be accomplished on demand for small amounts of data, or via subscribe and publish technologies for ongoing access to well-defined sets of information.

## CONCLUSIONS

Current technology trends are fueling the potential for early research and development efforts related to Full Scope Inline Simulation systems. Faster and cheaper equipment, combined with advances in software technology will make this a reality within six to eight years. But this will not be accomplished without overcoming many difficult technical challenges. The task of archiving massive amounts of disparate information in real-time, and then correlating such information into a meaningful and accurate representation is substantial, but this is only one of many such challenges for innovative developers to conquer.

There is a lot of new ground to be broken in order to achieve the level of automation described in this paper. However, this kind of capability will indeed provide users and regulatory agencies with the information required to reach a swift and accurate conclusion in the event of an incident. Even more important will be the contribution of the knowledge gained in support of future incident avoidance.

## BIOGRAPHIES

Daniel W. Nagala is President and CEO of UTSI International Corporation (www.utsi.com). He possess a Bachelor of Science (1976) in Computer Science and Systems Engineering from Northern Arizona University. Mr. Nagala is an industry recognized expert in the field of real-time pipeline automation and hydraulic modeling and simulation systems, with more than twenty-four (24) years of experience directly applied to this field.